DoD EPA DOE SERDP
Strategic Environmental Research and Development Program
Improving Mission Readiness Through Environmental Research

NETTS PROJECT/DEMONSTRATION SUMMARY

Title: Aerobic Biodegradation/Air Sparging NCBC-08-95

Lead PI/Affiliation: AFRL
Co-PI's/Affiliations: Battelle,ASU, OGI

Date/Duration:
Initiated - 04/96
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Abstract:

Air sparging is the process of injecting clean air directly into an aquifer for remediation of contaminated groundwater. For removing contaminants, air sparging relies on two basic mechanisms working either alone or in tandem: biodegradation and volatilization. The objective of air sparging is to force air through contaminated aquifer materials to provide oxygen for bioremediation and/or to strip contaminants out of the aquifer. Bioremediation refers to enhancing the growth of naturally occurring microorganisms that use contaminants such as petroleum products as a food source. In so doing, contaminated areas can be remediated naturally, with contaminants detoxified.

For this demonstration, two air sparging systems were installed: one in the source zone of a plume and one in a portion of a plume containing only dissolved phase contamination. This allowed a determination as to whether air sparging is more suited for source zone remediation or down-gradient, dissolved-phase remediation in addition to evaluating optimal system monitoring techniques, design and operational parameters.

Monitoring devices, installed within a 30-ft radius of a sparge well at one of the sites, consisted of 12 multi-level subsurface samplers, 12 neutron probe access tubes, 6 ground water monitoring wells, and 4 innovative soil vapor extraction directional wells. Air sparging monitoring techniques under investigation included: high-impulse borehole radar imaging, electrical resistance measuring, in situ pressure, and tracer testing including the use of sulfur hexaflouride (SF_6), and helium, as tracer gasses. In addition, system flowrates and injection depths were varied to examine the impact on air sparging performance. Also included were soil vapor extraction testing and groundwater analysis. Monitoring of the air sparging operations at the demonstration sites provided information to assess contaminant removal rates given different and changing environmental parameters. Information obtained from these operations was used to evaluate the overall effectiveness of, and provide system design data for, air sparging as a remediation technology.

Results/Conclusions:

Results from this study were directly used to develop a draft Air Sparging Design Paradigm (ASDP) that provides techniques for evaluating, designing, and operating air sparging systems. Recommended monitoring techniques include the use of helium tracer and in situ pressure testing, with more detailed SF_6 tracer testing under specific circumstances. A standard design approach was recommended to reduce costs associated with prolonged pilot testing, where a standard well spacing of 15 ft is prescribed, with injection rates between 5 to 20 scfm per well. Physical model studies confirmed the use of these relatively low flowrates, as higher injection rates appear to cause decreases in permeability. Pulsed air flow also is recommended and was confirmed in physical model studies that showed that pulsing the airflow has little effect on oxygen transfer, but does improve contaminant volatilization.

Publications:

(1) Johnson, R.L., et al., "Air Distribution During In Situ Air Sparging: Tracer and Geophysical Measurements", In Situ and On-Site Bioremediation: The Fourth International Symposium, April 28-May 1, 1997, New Orleans, Volume 1, (1997), (2) Bruce, C.L., et al., "Diagnostic Tools for Quantifying Oxygen Mass Transfer during In Situ Air Sparging". In Situ and On-Site Bioremediation: The Fifth International Symposium. April 18-22, 1999. San Diego, CA. 1999, (3) Bruce, C. L., "MTBE Removal by In Situ Air Sparging. Bioremediation of Chlorinated Solvents." The First International Conference on Remediation of Chlorinated and Recalcitrant Compounds. Monterey, CA. (1998), (4) Johnson, P.C. et al., In Situ Measurement of Effective Vapor-Phase Porous Medium Coefficients. Environmental Science and

Technology. 32. 34053409. (1998), (5) Johnson, P.C.. "Conventional and Innovative In Situ Air Sparging Pilot Test Procedures." ATV Danish National Groundwater Conference. March 11-12, 1997. Billund, Denmark. (1997)